Final Repl. A-709

RESEARCH DESIGN TO FORECAST DEMAND FOR NEW TYPES OF TECHNICIANS IN AN INDUSTRY

Research Report
Submitted
to
Director, Office of Manpower
Automation and Training
U. S. Department of Labor
Washington 25, D. C.

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Contract No. MDTA 19-63

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February 29, 1964

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FOREWARD

This report presents a research design to detect, define, and estimate demand for new technicians in an industry for any given area. While the illustrations are drawn from the textile industry, the main procedures are equally applicable to any industry.

Two major steps are required by the methodology. First, an exploratory investigation is considered imperative to discover both the technological changes dominating an industry and their estimated impact on new technical skills, as they pertain to technicians especially. This first phase requires interviews with top research and development engineers, scientists, and training personnel, utilizing a nonstructured questionnaire. Secondly, a statistical investigation is required, employing statistical inference, to estimate at specified probability levels the requirements of new technicians in the entire industry for stated periods in the future. It is recommended that the data be obtained by structured questionnaire either through direct personal interviews or by a special approach through the mailed survey. Other parts of the research design include plans for field work, analysis of data, and preparation of the report.

Rapid changes in scientific discovery and technological advance require that the brainpower and skillpower of employees be updated to change in order that industry may capitalize not only on new technology but also that the nation gain more rapid economic growth from faster exploitation of technology. The prerequisite to a more rapid exploitation of technology by the economy is the availability of trained scientists, engineers, technicians, and craftsmen. In order that the supply of technical skills be available when the demand for them develops, forecasts of requirements must be made with sufficient lead time to anticipate training demands. The research plan here presented outlines a method to prepare these forecasts.

SUMMARY

The objective of the study is to develop a research design in broad outline form which can be employed to detect, define, and forecast the need for emerging new technicians including planned sources of supply. A secondary objective is to develop the research design to provide information on upgrading of skilled workers, displacement of skilled or technical workers, and new types of skilled or technical workers to be employed in support of the new technician.

Detection of new technicians, including specific job specifications can only be achieved through detailed personal interviews with top company officials concerned with technological development and the development of personnel to cope with technological change. Two types of questionnaires have been developed to facilitate these interviews. The first type is on current technological problems and is non-structured. The second type is structured and relates to details on job specifications and training requirements for the new technicians, the need for which engineers, scientists, and others have discovered either independently or through personal interviews. Findings indicate that these interviews may successfully be concentrated in a small sub-sample of firms in the industry selected for study.

The industry-wide forecasts of the need for newly defined technicians are based upon usual sampling techniques with data collected to meet specifications essential for reliability in the final estimates.

Since the relative use of technical workers varies with company size and form of company organization, the sample design recognizes these differences in the universe of firms constituting an industry in a state. Multi-unit firms, due to a higher level of organizational development and greater financial strength, employ a greater variety of technicians. They tend to be more active in adopting new technology and they are, therefore, more cognizant of the need for new technical competencies in relationship to changing technology.

This is one of the strata. Single unit firms, while not as complex organizationally, vary widely as to interest and sophistication with respect to changing technology. Consequently, the process of stratification should recognize size of firm among the single unit companies.

The size of firms included in the universe depends on the type of industry and the intensity of interest in changing technology. Those industries more oriented to science, as chemicals, electronics and metal-working, require a greater representation of smaller firms in the strata than apparel companies, for instance. But usually, the universe needs to be confined to companies of 100 workers or more.

Data collection should be by a structured questionnaire. Personal interviews, using the questionnaire, are essential for multi-unit companies. A mailed questionnaire may be used with single unit companies. All field work needs to be accompanied by extensive publicity relative to the reasons for the study. Recognized statewide sponsors for the study, preferably from the industry under investigation, are recommended in order to gain a certain rapport with the industry.

The usual techniques of questionnaire follow-up and sub-sampling for non-response errors are, of course, a fundamental part of the research design.

I. THE PROBLEM

The explosion in knowledge, paced by the acceleration in scientific discovery and technological advance, has expanded the demand for workers with skills and technical know-how, and it has also given a new urgency to the necessity for updating skills. The competitive struggle of companies in this era is won or lost by their ability to solve technological problems ahead of their competitors at least. Uncertainty, hesitation, and delays in adoption of technological developments by large segments of industry will cause economic stagnation and a slow rate of economic growth.

The basic problem involves not only recognition by industrialists of the relationship of new technical skills to the ability of the company to exploit quickly and profitably technological change, but the basic problem involves also the extent to which company top management is willing to take positive action to define and develop a program to obtain needed new technical skills. The problem is concerned also with: (1) how definitively management perceives the specific technological trends affecting its company operations, and (2) how concisely management, and particularly that part of management concerned with research and development and engineering processes, relates technical skills to solution of technological problems arising out of scientific advance. The research design is prepared on the assumption that a clear conception of technical skill requirements is fundamental to solving pressing problems resulting from technological change. This report, while primarily interested in forecasting the demand for new technicians, recognizes, however, the interrelationships between how companies cope with new technologies relative to new technical skills and how this in turn affects the forecasts.

The objectives of this study are to:

1. Determine the dominant trends in technology for an industry.

2. Assess the relationship of trends in technology to technical skills required to solve technological problems arising in connection with technological trends.

3. Develop methods of forecasting future requirements for new technicians of industries based on a structured questionnaire.

II. PROPOSED METHOD TO SOLVE PROBLEM

The methodology provides first for an exploratory analysis of the critically urgent technological trends dominating an industry. It requires a second step, the establishment of the relationship of technological problems to problem solving through employment of specific technical skills. Summarization of important technological problems in an industry can only be done by the experts in the industry involved in this problem -- such as scientists, engineers, production experts, and labor training experts, both from industry and from labor. The methods of procedure are concerned also with how technical skills relate to the solution of technological problems and how development of such skills involves the training of technicians through public education, industry, and apprenticeship programs, with the advice of the scientists and engineers involved.

The problem of forecasting new technicians in an industry requires two major steps: First, personal interviews with top technical personnel in a subsample of large companies to determine major technological problems in the different industries and their relationship to skill requirements. This step is essential to provide data for the stimulation of others in the industry with the data, causing management in the industry as a whole to think effectively about its needs. A questionnaire survey to a larger representative sample of firms will be necessary also, as a second step, to test ability of top management to recognize company needs for new technicians in the particular industry.

Step one above is illustrated with data from the Georgia Skill Study. The data on technological problems related to new technicians were obtained as a by-product from the study. The specific results for the Georgia Textile Industry were obtained as a part of this study by employing intensive interviews with top management and technical personnel in representative textile firms in Georgia during the Summer and Fall of 1962. A two-part questionnaire was employed: (1) to summarize technological trends and problems, and (2) to

detect and define, with detailed job specifications, the new technicians that were evolving in the textile industry in the State. See Appendix, Exhibit 1 for samples of the forms which were employed in phase one of the study.

One objective of the personal interviews in phase one was to summarize the major technological problems in the industry. This information was obtained by use of a form entitled: "Analysis of New Types of Technical Workers for a Sample of Companies," Part I.

The following are a list of technological problems, given in generalized summary, now affecting the textile industry: (See Appendix, Exhibit 2.)

1. Improved raw materials involving synthetics. Multiple fiber blends increasing in importance. Methods of testing to determine qualities, quantities, and characteristics of fiber are growing in significance.

2. Since size of unit for manual handling has reached the limit, the trend is toward automatic handling with expensive equipment.

3. In recent years a complete breakthrough in textile machinery has occurred, leading toward automation of textile operations. There are larger, more expensive continuous flow machines; this requires synchronization of machines, development of automatic transfer machines. This results in increased speed of operations, larger packages. All of this means more sophisticated process controls, electronic and mechanical, to maintain flow and product uniformity, including production scheduling.

4. The trend toward expensive, complex machinery, involving electronic mechanisms and often also hydraulic or pneumatic, enlarge the problem of preventive maintenance.

5. The finishing of fabrics is changing and chemical technology, including coating for some types of products, is becoming more important and also more complex.

6. The textile mills serving the automobile industry are striving for a fabric that will equal the normal life of the automobile. Tire manufacturers are pursuing development of a tire without fabric materials.

7. The computer is of growing importance for data processing and management controls. In time computer use for production planning will grow.

8. Greater emphasis on statistical quality control, systems analysis, and the other tools of scientific management.

9. Emphasis on design and packaging is high. The style factor is becoming more important in all phases of industry.

10. The independent mills are not able to move as rapidly toward automation and computers as the larger integrated concerns. They are, however, going to high speeds and higher drafts, to machinery with antifriction bearings, electronically controlled, coupled with hydraulic or pneumatic systems.

11. Work is being done on elimination of some of the processes--go from opening to cards, sliver to direct spinning, from coarse roving, and elimination of slashing.

12. The large integrated textile companies are moving toward diversified types of production, involving, in time, lines of products not closely related to present products.

A second objective of phase one was to identify, define, and determine other information about new types of technicians with Part II of the questionnaire. The following are the Plant Job Titles of new technicians determined for the textile industry:

0401 Air Conditioning and Ventilating Technician
(5-83.941 Refrigeration Mechanic, any ind.; 5-83 Air Conditioning Mechanic, Commercial, any ind.)[1/]

Supervises, installs, tests, develops preventive maintenance plans for, and repairs air conditioning, ventilating, and refrigeration equipment. Must be able to read and understand blueprints and specifications and run and interpret tests. Works with air measuring devices such as pressure and velocity test equipment. Must also be able to work with conventional electrical testing equipment.

0502 Chemical Process Control Technician
(0-50.22 Laboratory Tester, prof. & kin.)

Operates between staff chemists and machine operators, testing or analyzing chemicals and materials entering and leaving process. Makes adjustments to bring processing operations into control to insure that product meets specifications. Uses colorimeters, makes density tests, and does quantitative analyses.

0503 Chemical Technician
(0-52.22 Laboratory Tester, prof. & kin.)

Operates a chemical testing laboratory investigating the use, cost, and improvement of all chemicals used in production. Requires a basic knowledge of chemicals, the ability to study chemical properties and reactions, and some mechanical engineering knowledge.

0509 Textile Chemical Technician
(0-52.22 Laboratory Tester, prof. & kin.)

Uses various procedures specified by the American Association of Textile Coloring Chemists and Tests specified by the American Society for Testing and Materials to check out dyes, e.g., comparisons of color strength, analyzes lubricants for fibers, etc. Serves to keep up with constant changes in materials and maintain constant control of the dyeing process. Will need a chemical and math background. Uses hot plates, ovens, color matching lights, sample dyeing equipment, weighing devices, fadeometers, and crock meters.

[1/] The Code Numbers and Job Titles given in parenthesis after most job Titles for New Technicians designate either technicians or skilled workers included in the Dictionary of Occupational Titles, U.S. Department of Labor, Bureau of Employment Security, which have similar technical skills.

0510 Textile Finishing Technician
(0-52.22 Laboratory Tester, prof. & kin.)[1/]

Studies various chemicals available for finishing textile materials to determine and plan the chemical or combination of chemicals needed to meet specifications; maintains quality control after the goods are woven, and teaches others how to mix chemicals. Must know textile chemical tests, and be able to use mathematics to determine costs. Uses viscometers and calculating machines.

1201 Electrical and Electronic Technician
(0-67 Electronic Technician, prof. & kin.)

Does maintenance, adjusting, and trouble-shooting on electric equipment. Must have a knowledge of electronics and electronic control instruments, e.g., temperature control equipment. Will use tube testers, ohmmeters, voltmeters, ammeters, and burner diagnostic machines. May be called upon to supervise others and to get along with operators.

1202 Electrical Technician
(0-67 Electrical Technician, prof. & kin.)

Installs, maintains, and repairs electrical equipment of a complicated circuit design including some sensitive electronic equipment. Must understand principles of electricity and basic electronics and be able to read circuits and wiring designs. Will use various electrical and some electronic test equipment.

1419 Textile Equipment Technician

Plans maintenance programs for mechanical, electrical, electronic, hydraulic and pneumatic systems, diagnoses failures, determines corrective action and supervises repairs by skilled repairmen. Must have an intimate knowledge of equipment and skill in using testing equipment. Must be able to use electrical and electronic testing equipment, specialized hand tools designed for the equipment, velocity measuring devices, tachometers, flow gauges, and various types of vibration and balance equipment.

1903 Industrial Engineering Technician
(0-68.73 Industrial Engineering Technician, prof. & kin.)

Will be engaged in setting standards as jobs change through job analysis. (Does the elementary work of the industrial engineer at less cost.) May work from this position into the position of departmental foreman. Uses normal time study tools.

[1/] Loc. cit.

2001 Industrial Water Filter and Sewerage Plant Technician
(7-54.621 Water-Treatment Plant Operator (waterworks))

Operates water filter and sewerage treatment plant or has supervision over preparation of materials for disposal plant. Must have a knowledge of water pumps, pressure flow meters, and enough basic chemistry for the application and control of chemicals.

2702 Textile Quality Control Technician
(0-50.42 Cloth Tester, Quality-garment, textile; 0-50.41 Laboratory Tester (textile) I; 0-50 Cloth Tester, garment; rubber goods)[1/]

Runs tests on count and weight of yarns and for fabrics, makes twist check, yarn strength tests, moisture checks, and other physical tests to maintain a high level of quality control. Uses strength testers, twist counters, reels, balances, and moisture testers. Will work with all types of operative and management people.

[1/] Loc. cit.

III. FIELD INVESTIGATION OF PROBLEM, JULY - SEPTEMBER 1963

During July - September 1963, Drs. Fulmer and Green, School of Industrial Management, Georgia Institute of Technology, experimented with methods to determine the most effective procedure to:

1. Communicate information on technological problems and job specifications of new technicians in the textile industry to various types and sizes of companies.

2. Obtain information through questionnaire procedures on the need for new technicians in the textile industry.

Experts from the A. French Textile School on the Georgia Tech Campus and the Executive Director, Georgia Textile Manufacturers Association, acted as consultants.

Three methods were employed to contact companies relative to the questionnaire. They were:

1. Personal interviews.

2. Single letter with questionnaire and materials.

3. A 2-phase letter.

The 2-phase letter was designed to attract interest and establish communication by asking the company president to do something easy or simple and then provide information through technologists on more complex matters.

The usual methods of follow-up were pursued on all three methods. The response ratio was as follows:

1. Personal interviews . . . 79 per cent.

2. Single letter with complete package of materials . . . 27 per cent.

3. 2-phase letter . . . 75 per cent.

The conclusions:

1. The response ratio depends upon gaining the attention of the company president through representation of a sponsor and by the type of approach

(personal interview or 2-phase letter).

2. Multi-unit firms due to complexity and problem of communication cannot be satisfactorily handled except by personal conference with top company personnel concerned with technological change.

3. Both the questionnaire and instructions (see Appendix, Exhibit 4), after three revisions, are acceptable to the textile industry.

4. The initial contact letter can influence the response ratio by stating clearly the objective at the beginning and also showing in unmistakable terms how the study will help the company responding.

The conclusion in general is that there is great interest on the part of company top management in changing technology and emerging new technicians. But management may be confused and uncertain as to how to move in solving these problems.

The 29 reporting units included in the field investigation report the following frequencies for additional workers in three years.[1/] See Table 1.

[1/] A frequency count for additional workers in 1 year is given in Appendix, Exhibit 3.

Table 1

Frequency Distribution of Number of New Technicians Reported as Required by the Georgia Textile Industry in 3 Years (Based on 2 multi-unit companies and 13 single unit companies with a total of 29 units)

Job Code	Plant Job Title	Frequency of Reports by 29 Units					Total Reporting one or more
		0	1	2	3	3 or more	
0401	Air Conditioning and Ventilating Technician	17	10	1	0	1	12
0502	Chemical Process Control Technician	27	1	0	1	0	2
0503	Chemical Technician	29	0	0	0	0	0
0509	Textile Chemical Technician	26	3	0	0	0	3
0510	Textile Finishing Technician	26	2	1	0	0	3
1201	Electrical and Electronic Technician	19	10	0	0	0	10
1202	Electrical Technician	22	4	1	1	1	7
1419	Textile Equipment Technician	20	8	1	0	0	9
1903	Industrial Engineering Technician	26	3	0	0	0	3
2001	Water Filter and Sewerage Plant Technician	28	1	0	0	0	1
2702	Textile Quality Control Technician	20	8	1	0	0	9
	TOTAL	260	50	5	2	2	59
	Number of Jobs Represented	0	50	10	6	8	74

Table 2 summarizes data on reports by type and size of companies on the need for new technicians in 3 years. There were 2 multi-unit companies and 13 single unit companies randomly selected on a pilot sample. A total of 29 reporting units are represented, 16 from the 2 multi-unit companies, and 13 from the single unit companies. The 29 units report a need for 74 of the 11 new technicians in 3 years. The fact that the multi-unit companies have relatively greater requirements for new technicians is shown in that an average of 3.1 new technicians was reported per unit in the multi-companies and 1.8 per unit for the single unit companies.

Table 2
Summary of New Technicians Needed in 3 Years as Reported by Companies in Field Test
July and August 1963
Georgia Textile Industry

Job Code	Item	4 - 99 Workers			100 - 249 Workers			250 - 499 Workers			500 & Over Workers			Summary, All Sizes		
		Multi-unit	Single Unit	Total	Multi-unit	Single Unit	Total	Multi-unit	Single Unit	Total	Multi-unit	Single Unit	Total	Multi-unit	Single Unit	Total
	Number of Units Reporting	2	4	6	3	4	7	3	2	15	8	3	11	16	13	29
	Number of Companies Represented	2	4	6	1	4	5	1	2	3	2	3	5	2	13	15
	Total Employment	146	200	346	412	646	1,058	1,243	850	2,093	9,452	3,585	13,037	11,253	5,281	16,534
	Number of New Technicians:															
0401	Air Conditioning & Ventilating Technician				1		1	3	1	4	10	1	11	14	2	16
0502	Chemical Process Control Technician		3	3		1	1								4	4
0503	Chemical Technician															
0509	Textile Chemical Technician										2	1	3	2	1	3
0510	Textile Finishing Technician		2	2	1		1		1	1				1	3	4
1201	Electrical and Electronic Technician				2	1	3	1		1	4	2	6	7	3	10
1202	Electrical Technician	1		1	1	1	2		3	3	7		7	9	4	13
1419	Textile Equipment Technician		1	1	1		1	3		3	5		5	9	1	10
1903	Industrial Engineering Technician				1		1	1		1		1	1	2	1	3
2001	Water Filter and Sewerage Plant Technician										1		1	1		1
2702	Textile Quality Control Technician		1	1	2	1	3	2	1	3	1	2	3	5	5	10
	TOTAL 11 CLASSES	1	7	8	9	4	13	10	6	16	30	7	37	50	24	74

IV. THE SAMPLE DESIGN

This section will consider: (1) definition of universe, (2) sampling problems, (3) stratification of the universe, and (4) analysis of sample size.

A. Definition of the Universe

Definition of the universe is often one of the most difficult problems in a research project. In conducting this study for an industry in a state, it would be possible to obtain company names and addresses from various directories. This method should be a last resort because of inaccuracies and the general lack of complete data on important characteristics of each company relative to size, type of product, etc., and also incompleteness as to all firms in the universe. It is suggested rather that the universe be that list of firms and reporting establishments tabulated quarterly by the State Employment Security Agency. This list is in constant process of revision and the universe is complete on all firms of 4 workers or over. Data on number of workers by month, type of production activity, and location are available so that any sample selection can be tied to a definable and dependable universe. Data are given also on multi-unit companies with location of each reporting establishment. Because of the significance of multi-unit firms to the adoption of new technology and their studies of the need for new technicians, it is vital to have a complete picture of multi-unit companies.

B. Sampling Problems

Some of the sampling problems which must be reflected in the sample design are the great variety of manufacturing activities, size of firm, and multi-unit companies. Obtaining addresses of sample companies and the name of the current president of each sample firm pose other problems.

The variation of the textile industry in Georgia, for example, relative to manufacturing activity, is as follows:

SIC Code	Industry Type	Number of Reporting Units March 1962
221	Weaving Mills, cotton	76
222	Weaving Mills, synthetic	13
223	Weaving, finishing mills, wool	12
224	Narrow Fabric Mills	6
225	Knitting Mills	57
226	Textile Finishing, except wool	16
227	Floor Covering Mills	89
228	Yarn and Thread Mills	56
229	Miscellaneous Textile Goods	27
	Total	352

SOURCE: County Business Patterns, First Quarter 1962.

The data show that 4 kinds of manufacturing firms dominate the textile industry in Georgia: Floor covering mills; weaving mills, cotton; knitting mills, and yarn and thread mills.[1]

Table 3 presents data on the size of the reporting establishments of the textile industry in Georgia, based on number of employees. Data are given on the number of multi-unit companies. While the size classes are distributed reasonably well among all the catagories, it should be noted that 43 per cent of the units have less than 100 workers.

Multi-unit companies increase in relative importance with the size category, dominating the class size with over 500 workers. This is not unexpected in view of the growing dominance of large companies in the American economy.

Other measures of the dominance of multi-unit companies are shown in the following summary:[2]

[1] In terms of the mid-March, 1962, total employment, the order of dominance of these industry types was: weaving mills (cotton), 44 per cent; yarn and thread mills, 15.0 per cent; floor covering mills, 12.7 per cent; and knitting mills, 9.5 per cent. The composite ratio of total textile employment in Georgia explained by the four types was 81.2 per cent.

[2] This summary is based on data from ESA-201 forms, provided in tabular summaries through the courtesy of the Employment Security Agency, Georgia Dept. of Labor.

Table 3

Relative Importance of Multi-unit Textile Companies in Georgia
First Quarter 1962

Size Class (Number of workers employed)	Total Number of Reporting Units	Number of Reporting Units in Multi-unit Companies	Percentage Number in Multi-unit Companies	Net Number of Single Unit Companies
4 - 19	51	3	0.6	48
20 - 99	95	13	13.7	82
100 - 249	76	31	40.8	45
250 - 499	51	25	49.0	26
500 and over	64	36	56.2	28
Total	337	108	32.0	229

SOURCE: County Business Patterns, First Quarter, 1962.

(1) 32 per cent of all covered reporting units are in multi-unit companies.

(2) 49 per cent of reporting units with 100 workers or more are in multi-unit companies.

(3) 52 per cent of total employment of the textile industry are in multi-unit companies.

(4) 56 per cent of total employment in units with 100 or more workers are in multi-unit firms.

The multi-unit companies which account for 32 per cent of all textile establishments in the State and 52 per cent of the employment, dominate greatly the textile industry.

C. Stratification of the Universe

Obviously, the sample will need to be stratified to reflect fully the differences in requirements of new technicians between multi-unit companies and single unit companies. It has already been seen that the frequency of occurrence of new technicians is about 50 per cent greater for each establishment from a multi-unit company than for a single unit company. Multi-unit companies also will have a headquarters office and probably satellite-like relationships between units in the firm. Communication will be improved by going to the headquarters office with the questionnaires designated for each reporting unit.

While stratification of the universe will need to begin with a separation between types of organization, whether multi- or single unit, a further stratification is suggested for single unit firms to reflect the effect of variations in size on the use of new technicians. The large single unit companies have been observed to have a greater sophistication relative to new technology, as well as in their thinking on the need for new technicians.

It is neither desirable nor even possible to separate the industry into further strata according to type of manufacturing processes. While technology does change between types of processes, the attitude of management toward technology and its relationship to new technicians is reflected more by type of organization and size of firm.

The cut-off point relative to size of company is placed at 100 workers for single unit companies. All units of multi-unit companies, however, should be included irrespective of size because of the nature of the interrelationships

which exist in the programming of operations. The problem of follow-up is simplified by this procedure also. The size catagories of 100 or more workers account for over 90 per cent of total employment in the Textile Industry in Georgia.

The size of sample which must be obtained in order to estimate future needs of eleven new types of technicians in the Textile Industry is the most important technical problem in this report. The large variety of information sought through the questionnaire and the great heterogeneity of the universe make sampling design factors extremely complex.

Since it is not possible to prepare sample calculations for all columns in the questionnaire nor for each job separately, these limitations of the problem require concentration on certain vital information. Since the forecast of number of workers is the central purpose of the study, the design should concentrate on either the one year or the three year forecasts. Field studies show that the 3-year forecast received much more attention than the 1-year forecast. Consequently, sample size calculations for illustrative purposes will focus on the 3-year forecast. Similar calculations are carried through for the one year forecast for comparative purposes in Appendix, Exhibit 3, without conclusive results, however.

There are eleven jobs shown in the questionnaire. Cochran[1] has suggested that separate calculations be made for a range of the values of the items in the questionnaire, and a median value be selected for sample size, which has been accomplished in Table 5 below. Tabulation procedures, however, should allow for computation of sampling error on each job individually in the 3-year forecast.

It is recommended, therefore, that the universe be stratified to two major subdivisions with three minor subdivisions in the single unit firm category.

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[1] Cochran, William G., Sampling Techniques, Second Edition, John Wiley and Sons, New York, 1963, pp. 79-80.

These are as follows for the Georgia Textile Industry, or for any one textile state chosen for study.

Major Strata	Minor Strata or Subdivisions
Multi-unit reporting establishments	All sizes in category
Single unit reporting establishments	100-249, 250-499, and 500 and over.

Preliminary field studies indicate that the additional jobs needed in 3 years tend to be reported in singles. This would suggest a Poisson probability distribution.

D. Analysis of Sample Size

1. Poisson Approximation of Job Occurrence

The frequency distribution of number of new technicians required in 3 years by 29 establishments in the Textile Industry indicates that the demand for new technicians may be best approximated by a Poisson distribution. Application of χ^2 test shows that Poisson distribution is a reasonably good fit to actual sample data distribution. The following table summarizes the results of χ^2 test:

Table 4

Poisson Approximation and χ^2 Test on Frequency Distribution of Number of New Technicians Required by the Georgia Textile Industry in 3 Years as Reported in the Pilot Study

Job Code	Frequency Reported by 29 Units 0	1	2 or more	Number of Jobs	Mean	χ^2 Value	$\chi^2_{0.05}$
0401	17 (16.7)	10 (9.2)	2 (3.1)	16	0.5517	0.5134	3.841
0502	27 (25.3)	1 (3.4)	1 (0.3)	4	0.1379	3.149	3.841
0503	29	0	0	0			
0509	26 (26.2)	3 (2.7)	0 (0.1)	3	0.1034	0.1049	3.841
0510	26 (25.3)	2 (3.4)	1 (0.3)	4	0.1379	2.2297	3.841
1201	19 (20.5)	10 (7.1)	0 (1.4)	10	0.3448	2.70	3.841
1202	22 (18.5)	4 (8.3)	3 (2.2)	13	0.4483	3.183	3.841
1419	20 (20.5)	8 (7.1)	1 (1.4)	10	0.3448	0.2402	3.841
1903	26 (26.2)	3 (2.7)	0 (0.1)	3	0.1034	0.1049	3.841
2001	28 (28.)	1 (0.96)	0 (0.04)	1	0.0345	--	--
2702	20 (20.5)	8 (7.1)	1 (1.4)	10	0.3448	0.2402	3.841
Total	260 (253.0)	50 (58.7)	9 (7.3)	74	0.2319	1.880	3.841

2. Statistical Analysis

Since the χ^2 test shows that the frequency of demand for new technicians in the textile industry can be approximated by Poisson distribution, the following discussion will be based on the assumption of the Poisson distribution for the statistics.

Unlike the case of normal distribution, the statistical analysis associated with the Poisson distribution is mainly concerned with estimation of the single parameter μ. This is due to the fact that the variance of the Poisson distribution is also μ. An application of the maximum likelihood method would readily show that the maximum likelihood estimator of the Poisson distribution is

$$\hat{\mu} = \frac{1}{n} \sum_{i=1}^{n} x_i = \bar{x} \tag{2.1}$$

The estimator has a Poisson distribution with mean μ and variance $\frac{\mu}{n}$. If the sample size is extremely large, i.e., $n \to \infty$, the distribution of the estimator may be approximated in terms of normal distribution. On the other hand, if the sample size is relatively small, distribution of the estimator is too skewed to allow normal approximation. The familiar t distribution does not apply in the case of Poisson distribution. As the result, the estimation of the confidence interval for the parameter μ requires careful attention.

The following discussion on estimation of the confidence interval and sample size will be divided into two sections; i.e., large sample case and small sample case.

a. Large sample case

If the sample size is sufficiently large, the central limit theorem applies and the confidence interval of μ corresponding to given confidence level α will be given by

$$p\left\{-z_\alpha \leq \frac{\sqrt{n}\,(\bar{x} - \mu)}{\sqrt{\mu}} \leq +z_\alpha\right\} = \alpha \tag{2.2}$$

with the confidence limits

$$\frac{\sqrt{n}\,(\bar{x} - \mu)}{\sqrt{\mu}} = \pm z_{\alpha} \tag{2.3}$$

The equation (2.3) yields the solution

$$\mu = \bar{x} + \frac{z_{\alpha}^2}{2n} \pm \left(\frac{z_{\alpha}^2 \bar{x}}{n} + \frac{z_{\alpha}^4}{4n^2}\right)^{1/2} \tag{2.4}$$

If we ignore the terms containing n higher than the order of $\sqrt{n}$, (2.4) can be simplified to

$$\mu = \bar{x} \pm z_{\alpha} \sqrt{\frac{\bar{x}}{n}} \tag{2.5}$$

Needless to say, the equation (2.4) is more accurate than the approximation formula (2.5) in estimating the confidence limits. However, it must be pointed out that, unless the sample size is very large, the equation (2.4) tends to overestimate the confidence limits, especially the lower limit. On the other hand, the equation (2.5) tends to underestimate the confidence limits, this being particularly true with regard to the upper limit.

The main advantage of the equation (2.5) is in its simplicity; it allows a crude estimate of required sample size when the range of error is specified in advance for estimation of the parameter μ . For the error of estimate E is equivalent to

$$E = \pm z_{\alpha} \sqrt{\frac{\bar{x}}{n}} \tag{2.6}$$

in the equation (2.5) and hence it follows directly that

$$n = \frac{z_{\alpha}^2 \bar{x}}{E^2} \tag{2.7}$$

As an example, assume that E is specified as p per cent of $\bar{x}$. Then the approximate number of sample size required for estimating the parameter μ within the given accuracy would be calculated from (2.7) as follows:

(2.8) $$n = \frac{z_{\alpha}^{2}}{p^{2}\bar{x}}$$

As a further illustration, the following table shows the approximate number of sample size required to estimate the parameter μ for each of the eleven catagories of new technicians in the textile industry when it is specified that α = 0.95 and p is specified as 0.1 and 0.2, respectively:

Table 5

Maximum Sample Sizes Required to Estimate 3 Year Demand[a] When Errors are Given as Percentages of Sample Means
(Based on 95 Per Cent Confidence Interval)

Job Code	E_1 = 10% of the Sample Mean[b]	Sample Size	E_2 = 20% of the Sample Mean[b]	Sample Size
0401	0.0552	696	0.1103	174
0502	0.0138	2,786	0.0276	695
0503	0		0	
0509	0.0103	3,715	0.0207	928
0510	0.0138	2,525	0.0276	695
1201	0.0345	1,114	0.0690	276
1202	0.0448	857	0.0897	214
1419	0.0345	1,114	0.0690	276
1903	0.0103	3,715	0.0207	927
2001	0.0035	11,135	0.0069	2787
2702	0.0345	1,114	0.0690	276

[a]Analysis of sample size for requirements of each technician type in 1 year is given in Appendix, Exhibit 3.

[b]Based on Sample Means given in Table 4.

b. Small Sample Case

The above analysis is predicated on the assumption of a large scale sampling. However, for most of the sampling problems where the Poisson distribution applies, a sufficiently large scale sampling may not always be available.

To begin with, the application of the Poisson distribution presumes the fact of the occurrence of the particular event (i.e., the demand for new technicians in our case) is rare. For an accurate estimate of the expected value of such random event, the sufficiency of the sample size is rather relative. For instance, the smaller the mean occurrence of an event, the larger the number of observations required will be in order to establish a reliable estimate of the mean.

Secondly, a small sample mean usually leads to a small sample sum in case of the Poisson distribution. However, a small sample sum implies a skewed sampling distribution of the mean; and hence the equations (2.4) and (2.5), which are based on the assumption of a symmetric distribution, cannot provide accurate estimates of the confidence intervals.

For the purpose of this study, we will make an arbitrary definition that a sample is small if

(2.9) $$S_o = n\bar{x} \leq 50$$

or, alternatively

(2.10) $$n \leq \frac{50}{\bar{x}}$$

Theoretically speaking, a Poisson distribution is skewed even when the parameter is large as 500. However, experiments show that if the sample sum exceeds 50, the equation (2.4) or the equation (2.5) can give us a fairly good approximation to the true values of the confidence limits.

Unfortunately, in case of small samples we do not have a convenient formula like (2.4) or (2.5) for estimation of the confidence intervals. Ordinarily, an accurate estimate of the confidence intervals of the Poisson parameter from small samples has to depend on a direct computation as shown below.

Let $M = n\mu$, and $S_o = x_1 + x_2 + \ldots + x_n$, the observed value of the sample sum of a specific observation. If α is the desired level of confidence probability, the lower limit and the upper limit of the confidence interval can be calculated by

(2.11) $$\mu_1 = \frac{M_1}{n}$$

and

(2.12) $$\mu_2 = \frac{M_2}{n}$$

where M_1 and M_2 are determined by

(2.13) $$p(S \geq S_o | M_1) = \frac{1 - \alpha}{2}$$

(2.14) $$p(S \leq S_o | M_2) = \frac{1 - \alpha}{2}$$

so that

(2.15) $$p(M_1 \leq M \leq M_2) = \alpha$$

The following table shows the values of M_1 and M_2 corresponding to $\alpha = 0.90$, $\alpha = 0.95$, and $\alpha = 0.99$ when S_o varies from 0 to 75:[1/]

[1/] Prepared by Burroughs 220, Datatron, with programmed formula.

Table 6

The Confidence Limits of $M = n\mu$ When S_o is Given and α is Specified

S_o	$\alpha = 0.90$		$\alpha = 0.95$		$\alpha = 0.99$	
	M_1	M_2	M_1	M_2	M_1	M_2
0	0.000	3.00	0.000	3.69	0.000	5.30
1	0.051	4.75	0.025	5.58	0.005	7.44
2	0.355	6.30	0.242	7.53	0.103	9.28
3	0.817	7.76	0.618	8.78	0.337	10.98
4	1.366	9.16	1.089	10.25	0.672	12.60
5	1.970	10.52	1.623	11.67	1.077	14.15
6	2.613	11.85	2.201	13.06	1.536	15.66
7	3.285	13.15	2.814	14.43	2.037	17.14
8	3.980	14.44	3.453	15.77	2.571	18.58
9	4.695	15.71	4.115	17.09	3.132	20.00
10	5.425	16.97	4.795	18.40	3.716	21.40
11	6.16	18.21	5.49	19.69	4.32	22.78
12	6.92	19.45	6.20	20.97	4.94	24.15
13	7.68	20.67	6.92	22.24	5.58	25.50
14	8.46	21.89	7.65	23.49	6.23	26.84
15	9.24	23.10	8.39	24.75	6.89	28.17
16	10.03	24.31	9.14	25.99	7.56	29.49
17	10.83	25.50	9.90	27.22	8.25	30.80
18	11.63	26.70	10.66	28.45	8.94	32.10
19	12.44	27.88	11.43	29.68	9.64	33.39
20	13.25	29.07	12.21	30.89	10.35	34.67
21	14.07	30.25	12.99	32.11	11.06	35.95
22	14.89	31.42	13.78	33.31	11.79	37.22
23	15.71	32.59	14.58	34.52	12.52	38.49
24	16.54	33.76	15.37	35.72	13.25	39.75
25	17.38	34.92	16.17	36.91	13.99	41.01
26	18.21	36.08	16.98	38.10	14.74	42.26
27	19.05	37.24	17.79	39.29	15.49	43.50
28	19.90	38.39	18.60	40.47	16.24	44.74
29	20.74	39.55	19.42	41.65	17.00	45.98
30	21.59	40.70	20.24	42.83	17.76	47.21
31	22.44	41.84	21.06	44.01	18.53	48.44
32	23.29	42.99	21.88	45.18	19.30	49.67
33	24.15	44.13	22.71	46.35	20.08	50.89
34	25.01	45.27	23.54	47.52	20.85	52.11
35	25.87	46.41	24.37	48.68	21.63	53.33
36	26.73	47.55	25.21	49.84	22.42	54.54
37	27.59	48.68	26.05	51.00	23.21	55.75
38	28.48	49.81	26.89	52.16	24.00	56.96
39	29.32	50.94	27.73	53.32	24.79	58.17
40	30.19	52.07	28.57	54.47	25.58	59.37
41	31.06	53.20	29.42	55.63	26.38	60.57
42	31.93	54.33	30.27	56.78	27.18	61.77
43	32.81	55.45	31.12	57.93	27.98	62.96

(Continued)

Table 6 (Continued).

The Confidence Limits of $M = n\mu$ When S_o is Given and α is Specified

S_o	$\alpha = 0.90$		$\alpha = 0.95$		$\alpha = 0.99$	
	M_1	M_2	M_1	M_2	M_1	M_2
44	33.68	56.58	31.97	59.07	28.79	64.15
45	34.56	57.70	32.82	60.22	29.60	65.35
46	35.44	58.82	33.67	61.36	30.41	66.53
47	36.32	59.94	34.53	62.51	31.22	67.72
48	37.20	61.06	35.39	63.65	32.03	68.91
49	38.08	62.18	36.25	64.79	32.85	70.09
50	38.96	63.29	37.11	65.92	33.66	71.27
51	39.85	64.41	37.97	67.06	34.48	72.45
52	40.73	65.52	38.83	68.20	35.30	73.63
53	41.62	66.63	39.70	69.33	36.13	74.80
54	42.50	67.75	40.56	70.46	36.95	75.98
55	43.39	68.86	41.43	71.60	37.78	77.15
56	44.28	69.97	42.30	72.73	38.61	78.32
57	45.17	71.07	43.17	73.86	39.44	79.40
58	46.06	72.18	44.04	74.98	40.27	80.66
59	46.96	73.29	44.91	76.11	41.10	81.83
60	47.85	74.40	45.79	77.24	41.94	83.00
61	48.74	75.50	46.66	78.36	42.77	84.16
62	49.64	76.60	47.54	79.49	43.61	85.32
63	50.54	77.71	48.41	80.61	44.45	86.48
64	51.43	78.81	49.29	81.73	45.29	87.64
65	52.33	79.91	50.17	82.85	46.13	88.80
66	53.23	81.01	51.05	83.97	46.97	89.96
67	54.13	82.11	51.93	85.09	47.81	91.12
68	55.03	83.21	52.81	86.21	48.66	92.27
69	55.93	84.31	53.69	87.33	49.50	93.43
70	56.83	85.41	54.57	88.45	50.35	94.58
71	57.73	86.51	55.46	89.56	51.20	95.73
72	58.64	87.61	56.34	90.68	52.05	96.89
73	59.54	88.71	57.23	91.79	52.90	98.04
74	60.44	89.81	58.11	92.91	53.75	99.19
75	61.35	90.91	59.00	94.09	54.60	100.33

With the use of Table 6, the confidence intervals of the average demand for new technicians can be estimated in the following manner. For instance, take the example of demand for new air conditioning and ventilating technicians. According to our survey, 29 textile firms in Georgia reported a total demand of 16. That is, $n = 29$ and $S_o = 16$. If $\alpha = 0.95$, the values of M_1 and M_2 corresponding to $S_o = 16$ are 9.14 and 25.99, respectively, from Table 6. Dividing M_1 and M_2 by 29 we obtain the 95 per cent confidence limits for the average demand for new air conditioning and ventilating technicians as 0.3152 and 0.8962, respectively, per textile firm during the forthcoming three year period.

Proceeding in similar manner, the following table summarizes the estimates of 95 per cent confidence limits for average demand by textile firms of eleven different categories of new technicians included in the study:

Table 7

Ninety-Five Per Cent Confidence Intervals of the Average Demand for New Technicians by Textile Industry

Job Code	$\bar{x}$	S_o	$\alpha = 0.95$		$(M_1, M_2)/29$	
			M_1	M_2	μ_1	μ_2
0401	0.5517	16	9.14	25.99	0.3152	0.8962
0502	0.1379	4	1.089	10.25	0.0376	0.3535
0503	0.0	0	0.0	3.7	0.0	0.1276
0509	0.1034	3	0.618	8.78	0.0213	0.3028
0510	0.1379	4	1.089	10.25	0.0376	0.3535
1201	0.3448	10	4.795	18.40	0.1653	0.6345
1202	0.4483	13	6.92	22.24	0.2386	0.7669
1419	0.3448	10	4.795	18.40	0.1653	0.6345
1903	0.1034	3	0.618	8.78	0.0213	0.3028
2001	0.0345	1	0.025	5.6	0.0009	0.1931
2702	0.3448	10	4.795	18.40	0.1653	0.6345
	0.2319	74	58.11	92.91	0.1822	0.2913

Table 7 leads us to the following inference with regard to the total demand for new technicians by the textile industry in Georgia. Since there are 207 textile firms of various sizes and types included in the universe,[1] we would expect the total demand for new technicians of various descriptions by these textile firms to average within the following ranges with 95 per cent probability.

[1]All multi-unit firms and single unit companies employing 100 workers or over.

Table 8

Forecast of Demand for New Technicians in the Textile Industry
July, 1963 - June, 1966
Based on Sample Means and the 95 Per Cent Confidence Limits
of the 29 Textile Establishments Included in the Survey

Job Code	Expected Average Demand		
	Lower Limit	Mean	Upper Limit
0401	65.25	114.8	185.51
0502	7.78	28.7	73.17
0503	0.00	0.0	26.41
0509	4.41	21.5	82.68
0510	7.78	28.7	73.17
1201	34.22	71.7	131.34
1202	49.39	93.2	158.75
1419	34.22	71.7	131.34
1903	4.41	21.5	62.68
2001	0.19	7.2	39.97
2702	34.22	71.7	131.34
Combined job[a]	403.94	530.8	645.81

[a]Combined job is based on the average of eleven different categories of jobs. Hence the expected number for individual job categories will add up to the expected number for the combined job but the limits of predictions for individual job categories will not, in general, add up to the limits of predictions for the combined job due to the nature of Poisson distribution.

3. Sampling Ratios by Stratum for General Case

The analysis in sections 1 and 2 has shown that the total sample size required (276 establishments) exceeds the total universe of firms in Georgia. The entire 207 textile establishments in Georgia would therefore be required. This means that for a textile industry no larger than the Georgia textile industry a 100 per cent census of all establishments of 100 or more employees is necessary.

In order to generalize the sample design to states or areas with more than 276 establishments, there is developed below allocations to stratum of the size of sample required, as well as calculations of the actual sampling ratio by stratum for a large universe. The results are given in Tables 9 and 10, based on large sample theory. For these tables it has been assumed that the total universe is constituted of 2,000 firms, distributed to company type and company size similar to the Georgia textile industry in the second Quarter of 1962, shown in Table 3.

Table 9 shows allocation of n (276 sample size) to strata, assuming the same variance as for the 11 technicians studied in 29 establishments of the Georgia textile industry during the summer of 1963. The method of allocation follows procedures developed by Cochran.[1]

Table 10 presents the sampling ratios for each stratum. It is noted that the proportion of the different strata which will be required by the sample requirements of each, given in Table 9, varies from 3.5 per cent for single unit establishments, employing 100 - 249 workers, to 17.8 per cent for those establishments employing 500 or more workers. By types of companies, the sampling ratio is only 10.4 per cent for single unit companies to 17.0 per cent for multi-unit companies. The overall sampling for the entire universe (2,000 establishments assumed) is 13.8 per cent.

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[1] Cochran, William G., Sampling Techniques, Second Edition, John Wiley and Sons, 1963, pp. 95 - 113.

Table 9

Estimation of Sample Size[a] in Different Stratum
of a Textile Industry, with 2,000 Reporting Establishments Assumed
(n = 276, Calculated by Poisson Distribution)

Strata	N_h	s_h	$N_h s_h$	$\frac{N_h s_h}{\sum_{h=1}^{L} N_h s_h}$	n_h
Multi-unit Companies	1044	0.48	501	0.642	177
Single unit Companies					
1. 100-249	434	0.10	43	0.055	15
2. 250-499	252	0.40	101	0.130	36
3. 500 and over	270	0.50	135	0.173	48
Subtotal	956	--	279	0.358	99
Total	2000	--	780	1.000	276

[a]Where N_h equals number of firms in stratum, s_h equals the standard deviation, and n_h equals the number of units in total sample (n) from stratum h.

SOURCE: Cochran, William G., Sampling Techniques, Second Edition, John Wiley and and Sons, 1963, pp. 95-113.

Table 10

Relationship of the Calculated Sample Size of Assumed Number (2,000) Firms in Industry

Company Type and Size	Calculated Sample Size	Number of Firms in Universe	Recommended Sampling Ratio
Multi-unit companies	177	1044	17.0
Single unit companies:			
1. 100-249	15	434	3.5
2. 250-499	36	252	14.3
3. 500 and over	48	270	17.8
Subtotal	99	956	10.4
Total	276	2000	13.8

V. QUESTIONNAIRE DESIGN

The questionnaire design must provide for and obtain the necessary information not only to determine individual company needs for new technicians, but it should also secure related information to permit sample inference to a specified level of significance. Data obtained through such a design will permit forecasts of industry requirements for new technicians with a certain degree of reliability. Information on new technician type jobs is specific as to new technicians already determined from personal interviews. This is necessary in order to measure accurately the recognition bias of companies for specific jobs. However, open end questions both on: (1) technological problems and (2) new jobs, permit listing of technicians unrelated to those shown in the questionnaire. The new jobs which may be listed will represent a form of incomplete reporting by the sample establishments, and will introduce a type of bias in the totals for such jobs which must be recognized in the interpretations.

In addition to a structured questionnaire on specific new technicians already identified for the industry, additional requested information to each job is required to show:

1. Number already working in this job even though incompletely trained.
2. Number of skilled workers or technicians to be upgraded into new technician jobs needed.
3. Number to be hired from vocational-technical training centers.
4. Number of skilled workers or technicians to be displaced by new technician, resulting in job loss.
5. Number of skilled workers or technicians to be employed to support the activity contemplated for the new technician who will be employed.

Basic data on total employment three years previous, current total employment, expected total employment in one year, and expected total employment in three years are required as a tie-in to the benchmark period of the sample, the first quarter of 1962. Trends in employment and errors of estimates relative to

actual employment three years previous are basic to determining the size of the errors in the estimate.

Supporting information on the type and scale of company training programs for technicians is desirable in order to determine a deficit in present and future company needs. All this latter information should be structured in the questionnaire. A sample of the questionnaire already field tested for the Georgia Textile Industry is given in Appendix, Exhibit 4.

VI. INSTRUCTIONS TO FILL OUT QUESTIONNAIRE

The instructions to fill out the questionnaire are presented as part of the form itself, which is prepared as an eight page continuous form. The instructions are interspersed with sections of the questionnaire where applicable.

The acceptability and practicality of the instructions were field tested along with the questionnaire during July and August, 1963. Numerous revisions have been introduced in response to suggestions from company personnel based on field contacts. The revised instructions, along with the questionnaire, are presented in Appendix, Exhibit 4.

VII. DATA COLLECTION

The method of procedure recommended to collect data consists of three different methods of attack, namely: (1) survey by mail or personal interviews, with follow-up; (2) personal interviews to check nonresponse bias; and (3) personal interviews to determine nonrecognition bias.

1. Survey by mail or personal interviews

The matter of getting questionnaires to companies in the hands of persons who are competent and interested in filling them out is a major problem. Different methods must be employed with multi-unit companies than with single unit companies. For multi-unit companies, questionnaires will need to be delivered by a skilled analyst to the person or to a group in the company responsible for

Research and Development on changing science and technology, and the training related thereto. Various methods of testing have demonstrated that mailed survey methods are inadequate to communicate the problems and requirements of the questionnaire to a multi-unit company with widespread interests and scattered manufacturing units. It is recommended that appointments with appropriate persons be arranged by letter and telephone with the president of the company. At the appointed time, the skilled analyst should present himself to the group designated by the president and explain the purpose of the study, what it will mean to the cooperating company, the type of information sought and how it may be obtained for the different reporting units in the company.

A two-phase mailed approach is proposed for the single unit companies. In the first letter the president of the company is asked to do something simple. He is requested to appoint some person or group to assist with a research study into the impacts of changing technology on new technicians. He is also asked to check and return a form on technological changes in the Textile Industry. The second letter includes the questionnaire to be mailed directly to the person designated by the president to cooperate in the study of the impacts of changing technology on the Textile Industry. Copies of proposed letters are given in Appendix, Exhibit 5.

As the questionnaires are received, the usual procedures are recommended for checking against controls, editing, and follow-up by mail, telephone, and even limited personal contacts if necessary to get adequate information in the returned questionnaires. Experience with field work in Summer of 1963 and on similar studies indicate that two letter follow-ups, supplemented by telephone calls, and a few personal contacts will be required if the response ratio is to approximate 75 per cent.

Validation of results may be obtained by checking company reports of total employment against reported employment on ES-201 forms required quarterly from the employer by the State's Employment Security Agency.

2. Personal interviews to check nonresponse bias

Nonresponse bias is a real problem in obtaining satisfactory reliability in the results. In order to handle this problem satisfactorily, a method of measuring nonresponse bias is recommended. This would be a limited follow-up in personal interviews to obtain reports from a satisfactory ratio of non-respondents to adequately represent the problem in sample inference. A 25 per cent sample of nonresponding firms should be drawn in order to measure this bias. In the case of the multi-unit companies, missing units should be pursued not only to companies failing to reply at all but also to those companies which failed to return all of the reporting units in the universe. The objective would be to complete the entire picture on reporting units in any given multi-unit company.

3. Personal interviews to determine nonrecognition bias

Once the cut-off date for returns to the mailed questionnaires are reached, a 20 per cent sub-sample of the firms replying, selected by random methods from strata, for personal interviews is recommended. The objective is to check nonrecognition bias of companies for the new technicians structured in the questionnaire. Contact should preferably be by letter to company presidents, seeking an appointment with persons in the company responsible for adoption of new technology.

VIII. STATISTICAL ANALYSIS

Examples of the analytical tables which may be developed from computer print-outs are illustrated by 16 tables which have been developed for the Textile Industry. The tables are as follows:

Table	Title of Table
1.	Percentage Sample Response of Firms in Sample
2.	Sample Response of Firms by Size of Firms
3.	Comparison of Total Reported Employment with Actual Total Employment for 3 Years Previous and Fall 1962
4.	Current Employment Related to Expected Employment 1 Year and 3 Years with 5 Year Projected Employment by Industry Type
5.	Current Employment Related to Expected Employment 1 Year and 3 Years with 5 Year Projected Employment by Company Type and Size
6.	Summary of Training Programs for New Technicians
7.	Summary of Reporting on Extent of Technological Trends Affecting Reporting Units
8.	Summary of Additional Technological Problems Reported
9.	Relationship of Trends in Demand for Eleven New Technicians to Industrial Category
10.	Relationship of Trends in Demand for Eleven New Technicians to Size of Firm Based on JI - Covered Employment
11.	Current Use and Future Requirements of Eleven New Technicians by Plant Job Title
12.	Relationship of Relative Number of Eleven New Technicians Reported in Mailed Surveys to Personal Interviews
13.	Adequacy of Plans to Meet Expected Demand for Eleven New Technicians by Industry
14.	Adequacy of Plans to Meet Expected Demand for Eleven New by Size of Firm
15.	Relationship of Growth in Demand for Eleven New Technicians to Creation of Jobs or Loss of Jobs by Other Technical or Skilled Workers by Industry
16.	Relationship of Growth in Demand for New Technicians to Creation of Jobs or Loss of Jobs by Other Technical or Skilled Workers by Firm Size

Table 1
Percentage Sample Response of Firms in Sample

Industry	Sampling Ratio: Number of Firms in- Universe	Sampling Ratio: Number of Firms in- Sample	Ratio	Firms Responding: Number	Firms Responding: Per Cent Response	Sample Response in Terms of March 1962 Employment: Total Employment of Sample	Sample Response in Terms of March 1962 Employment: Total Employment of Respondents	Sample Response in Terms of March 1962 Employment: Per Cent Response
1. Weaving, cotton								
2. Weaving, synthetics								
3. Weaving, finishing mills, wool								
4. Narrow fabric mills								
5. Knitting mills								
6. Textile finishing, except wool								
7. Floor covering mills								
8. Yarn & thread mills								
9. Miscellaneous textile goods.								
TOTAL								

Table 2
Sample Response of Firms by Size of Firms

Company Type and Size	Sampling Ratio: Number of Firms in- Universe	Sampling Ratio: Number of Firms in- Sample	Ratio	Firms Responding: Number	Firms Responding: Per Cent Response	Sample Response in Terms of March 1962 Employment: Total Employment of Sample	Sample Response in Terms of March 1962 Employment: Total Employment of Respondents	Sample Response in Terms of March 1962 Employment: Per Cent Response
I. Single Unit:								
100 - 249								
250 - 499								
500 & over								
Subtotal								
II. Multi-unit Companies								
TOTAL								

Table 3
Comparison of Total Reported Employment with Actual Total Employment for 3 Years Previous and Spring 1962

Company Type and Size	Employment 3 Years Previous			March 1962 Employment		
	Reported	Actual	Ratio Reported to Actual	Reported	Actual	Ratio Reported to Actual
I. Single Unit:						
100 - 249						
250 - 499						
500 & over						
Subtotal						
II. Multi-unit Companies						
TOTAL						

Table 4
Current Employment Related to Expected Employment
1 Year and 3 Years with 5 Years Projected Employment
by Industry Type

Industry Type	Current Employment	Expected Employment		Projected Employment in 5 Years
		1 Year	3 Years	
1. Weaving, cotton				
2. Weaving, synthetics				
3. Weaving, finishing mills, wool				
4. Narrow fabric mills				
5. Knitting mills				
6. Textile finishing, except wool				
7. Floor covering mills				
8. Yarn & thread mills				
9. Miscellaneous textile goods				
TOTAL				

Table 5
Current Employment Related to Expected Employment
1 Year and 3 Years with 5 Years Projected Employment
by Company Type and Size

Company Type and Size	Current Employment		Expected Employment		Projected Employment in 5 Years
	Number	Per Cent Total	1 Year	3 Years	
I. Single Unit					
100 - 249					
250 - 499					
500 & over					
Subtotal					
II. Multi-unit Companies					
TOTAL					

Table 6
Summary of Training Programs for New Technicians

Training Program	Number Reporting		Number Completing Program	
	Total Number of Companies	Per Cent Companies Reporting	Total	Average Per Company
1. On-the-job training				
2. Company classroom				
3. Night school of college				
4. Night school of vocational-technical school				
5. Industry training short courses				
6. Major suppliers (Dupont, etc.)				
7. Other				

Table 7
Summary of Reporting on Extent of Technological Trends Affecting Reporting Units

Technological Trends	Single Unit Companies Reporting		Multi-unit Companies Reporting	
	Number	Per Cent Total Number Reporting	Number	Per Cent Total Number Reporting
1. Improved raw materials involving synthetics. Multiple fiber blends involving both synthetics and natural fibers will probably increase in importance. Methods of testing to determine qualities, quantities, and characteristics of fiber are growing in significance.				
2. Since size of unit for manual handling has reached the limit, the trend is toward automatic handling with expensive equipment.				
3. In recent years a complete breakthrough in textile machinery has occurred, leading toward automation of textile operations. There are larger, more expensive continuous flow machines; this requires synchronization of machines, development of automatic transfer machines. This results in increased speed of operations, larger packages. All of this means more sophisticated process controls, electronic and mechanical, to maintain flow and product uniformity, including production scheduling.				
4. The trend toward expensive, complex machinery, involving electronic mechanisms and often also hydraulic or pneumatic, enlarge the problem of preventive maintenance.				
5. The finishing of fabrics is changing and chemical technology, including coating for some types of products, is becoming more important and also more complex.				
6. The textile mills serving the automobile industry are striving for a fabric that will equal the normal life of the automobile. Tire manufacturers are pursuing development of a tire without fabric materials.				
7. The computer is of growing importance for data processing and management controls. In time computer use for production planning will grow.				
8. Greater emphasis on quality control, systems analysis, and the other tools of scientific management.				

Table 7
Summary of Reporting on Extent of Technological Trends Affecting Reporting Units - continued

Technological Trends	Single Unit Companies Reporting		Multi-unit Companies Reporting	
	Number	Per Cent Total Number Reporting	Number	Per Cent Total Number Reporting
9. Emphasis on design and packaging will remain high. The style factor is becoming more important in all phases of industry.				
10. The independent mills are not able to move as rapidly toward automation and computers as the larger integrated concerns. They are, however, going to high speeds and higher drafts, to machinery with anti-friction bearings, electronically controlled, coupled with hydraulic or pneumatic systems.				
11. Work is being done on elimination of some of the processes--go from opening to cards, sliver to direct spinning, from coarse roving, and elimination of slashing.				
12. The large integrated textile companies are moving toward diversified types of production, involving in time lines of products not closely related to present products.				

Table 8
Summary of Additional Technological Problems Reported

Technological Problems	Companies Reporting	
	Number	Per Cent of Total

Table 9
Relationship of Trends in Demand for Eleven New Technicians to Industrial Category

Industry Type	Number of New Technicians Working Currently	Number of New Technicians Expected to be Employed in-		Projected Employment of New Technicians in 5 Years
		1 Year	3 Years	
1. Weaving, cotton				
2. Weaving, synthetics				
3. Weaving, finishing mills, wool				
4. Narrow fabric mills				
5. Knitting mills				
6. Textile finishing, except wool				
7. Floor covering mills				
8. Yarn & thread mills				
9. Miscellaneous textile goods				
TOTAL				

Table 10
Relationship of Trends in Demand for 11 New Technicians to Size of Firm
Based on JI - Covered Employment

Company Type and Size	Current Employment		Number of New Technicians Expected to be Employed in-		Projected Employment of New Technicians in 5 Years
	Number	Per Cent Total	1 Year	3 Years	
I. Single Unit:					
100 - 249					
250 - 499					
500 & over					
Subtotal					
II. Multi-unit Companies					
TOTAL					

Table 11
Current Use and Future Requirements of 11 New Technicians by Plant Job Title

Job Code	Plant Job Title	Estimated Number Working Currently		Estimated Number Expected to be Employed in-			
				1 Year		3 Years	
		Number	Lower Limit of Estimate	Number	Lower Limit of Estimate	Number	Lower Limit of Estimate
0401	Air Conditioning & Ventilating Technician						
0502	Chemical Process Control Technician						
0503	Chemical Technician						
0509	Textile Chemical Technician						
0510	Textile Finishing Technician						
1201	Electrical and Electronic Technician						
1202	Electrical Technician						
1419	Textile Equipment Technician						
1903	Industrial Engineering Technician						
2001	Water Filter and Sewerage Plant Technician						
2702	Textile Quality Control Technician						

Table 12
Relationship of Relative Number of 11 New Technicians
Reported in Mailed Surveys to Personal Interviews

Item	Mailed Survey	Personal Interviews
I. Number of Firms Reporting		
II. Current Employment		
1. Total		
2. New Technicians		
3. Ratio to Total		
III. Expected Employment in One Year		
1. Total		
2. New Technicians		
3. Ratio to Total		
IV. Expected Employment in 3 Years		
1. Total		
2. New Technicians		
3. Ratio to Total		

Table 13
Adequacy of Plans to Meet Expected Demand for 11 New Technicians
by Industry

Industry	Expected Demand in 1 Year					Expected Demand in 3 Years				
	Number Employed	Methods of Meeting Demand			Per Cent Demand Not Filled	Number Employed	Methods of Meeting Demand			Per Cent Demand Not Filled
		Training and Upgrading		Employed from Training Centers or Other Sources			Training and Upgrading		Employed from Training Centers or Other Sources	
		Number	Per Cent	Number	Per Cent		Number	Per Cent	Number	Per Cent

Table 14
Adequacy of Plans to Meet Expected Demand for 11 New Technicians by Size of Firm

Company Type and Size	Number Employed	Expected Demand in 1 Year			Expected Demand in 3 Years		
		Methods of Meeting Demand		Per Cent Demand Not Filled	Methods of Meeting Demand		Per Cent Demand Not Filled
		Training and Upgrading	Hired from Training Centers or Other Sources		Training and Upgrading	Hired from Training Centers or Other Sources	
		No. Per Cent	No. Per Cent		No. Per Cent	No. Per Cent	
I. Single Unit:							
100 - 249							
250 - 499							
500 & over							
Subtotal							
II. Multi-unit Companies							
TOTAL							

Table 15
Relationship of Growth in Demand for 11 New Technicians to Creation of Jobs or Loss of Jobs by Other Technical or Skilled Workers by Industry

Industry	Expected Demand in 1 Year				Expected Demand in 3 Years			
	Number	Other Jobs Created		Other Jobs Lost	Number	Other Jobs Created		Other Jobs Lost
		No.	Ratio	No. Ratio		No.	Ratio	No. Ratio
1. Weaving, cotton								
2. Weaving, synthetics								
3. Weaving, finishing mills, wool								
4. Narrow fabric mills								
5. Knitting mills								
6. Textile finishing, except wool								
7. Floor covering mills								
8. Yarn & thread mills								
9. Miscellaneous textile goods								
TOTAL								

Table 16
Relationship of Growth in Demand for 11 New Technicians to Creation of Jobs
by Other Technical or Skilled Workers by Firm Size

Company Type and Size	Expected Demand in 1 Year					Expected Demand in 3 Years				
	Number	Other Jobs Created		Other Jobs Lost		Number	Other Jobs Created		Other Jobs Lost	
		No.	Ratio	No.	Ratio		No.	Ratio	No.	Ratio
I. Single Unit:										
100 - 249										
250 - 499										
500 & over										
Subtotal										
II. Multi-unit Companies										
TOTAL										

IX. OUTLINE OF REPORT

Summary and Recommendations

1. Introduction
    - A. Nature of the Problem
    - B. Objectives and Scope
    - C. Definitions
    - D. Brief Methodology
2. Sample Response
3. Employment Trends
4. Analysis of Company Training Programs
    - A. Type and Importance of Different Programs
    - B. Yearly Rate of Output from Training Programs
5. Current Use and Future Demand for Eleven New Technicians
    - A. Major Industries
    - B. Size of Firms by Form of Company Organization
    - C. Plant Job Title
6. Analysis of Technological Trends
    - A. Reporting Frequency for 12 Defined Trends
    - B. Summary of New Technological Problems Reported
7. Nonrecognition Bias for New Technicians from Mailed Questionnaire
8. Meeting Demand for New Technicians
    - A. Company Training by Type of Company Organization
    - B. Employment from Outside Training Sources
9. Impact of Eleven New Technicians on Other Skilled and Technical Workers
    - A. Number of Skilled Workers or Technicians Displaced
    - B. Number of Skilled Workers or Technicians to be Added in Support of New Technicians

10. Forecasting Demand for New Technicians

    A. Recognition Bias from Mailed Survey

    B. Estimated Future Requirements for Specific Plant Job Titles in One Year and Three Years

    C. Error of Estimate at the 95 Per Cent Confidence Level

    D. Expanding Estimates to National Totals

11. Summary and Conclusions

Appendix

    A. Methodology

    B. Statistical Tables

X. SUGGESTED LIST OF CHARTS

1. Trends in total employment of sample firms related to current and expected employment of new technicians in one and three years.

2. Ratio of new technicians to total employment currently and in one and three years by type of company and size of reporting units.

3. Ratio of new technicians to total employment currently, and in one and three years by major industry.

4. Recognition bias for new technicians by major industry.

5. Recognition bias for new technicians by type of company and size of reporting unit.

6. Relationship of demand for new technicians in one year and three years to expected displacement of skilled and technical workers by major industry.

7. Relationship of demand for new technicians in one year and three years to expected displacement of skilled and technical workers by company type and size of reporting unit.

8. Expected employment of skilled and technical workers in one year and three years to support additions of new technicians by type of industry.

9. Addition of skilled and technical workers in one year and three years to support new technicians by company type and size of reporting unit.

10. Relationship of training and upgrading of workers to demand for new technicians by type of industry.

11. Relationship of training and upgrading of workers to demand for new technicians by type of company and size of reporting unit.

12. Relationship of hiring from outside training sources to demand for new technicians by company type and size of reporting units.

13. Recognition bias for new technicians from mailed survey by type of company and size of reporting unit.

14. Estimated demand for specific new technicians in three years with limits of estimates at 95 per cent confidence intervals.

APPENDIX

EXHIBIT 1

Sample of Two Questionnaire Forms Employed to Discover Technological Trends in Any Industry and to Determine New Technicians Developing Thereby

School of Industrial Management
Engineering Experiment Station
Georgia Institute of Technology

Office of Manpower
Automation and Training
U. S. Department of Labor
Budget Bureau No. _____

STUDY OF TECHNICIAN TYPES OF WORKERS

Confidential Confidential

ANALYSIS OF NEW TYPES OF TECHNICAL JOBS FOR A SAMPLE OF COMPANIES

Part I. General and identifying information (one copy for each company).

A. Firm name _____

B. Outline briefly the most important technological (or scientific) trends which will influence your industry in the next few years and which you expect to have a big affect on the technical skills of workers.

1. _____

_____

2. _____

_____

3. _____

_____

4. _____

_____

5. _____

_____

6. _____

_____

7. _____

_____

8. _____

_____

9. _____

_____

(over)

Firm name _____

Notes: _____

School of Industrial Management
Engineering Experiment Station
Georgia Institute of Technology

Office of Manpower
Automation and Training
U. S. Department of Labor
Budget Bureau No. _____

STUDY OF TECHNICIAN TYPES OF WORKERS

Confidential Confidential

ANALYSIS OF NEW TYPES OF TECHNICAL WORKERS FOR A SAMPLE OF COMPANIES

Part II. Identifying information on companies and specific data on new types of technical workers expected to develop by June, 1967. (Complete one form for each new type of technical job). (3) Col. 1

1. Firm name _____ Cols. 2-10

2. Data already obtained in Part I.

3. Qualification analysis for new type of technical[1] worker:

   a. What will worker do?

   _____

   _____

   _____

   b. How will worker do it?

   _____

   _____

   _____

   c. Why will worker do it?

   _____

   _____

   _____

---

[1]Criteria for identifying a technical job.

a. Work level between that of a skilled and a scientific profession.
b. Job requires technical competency based on specialized training in technical subjects which involve the sciences and mathematics.
c. Person's work involves application for technical knowledge and technical understanding.
d. The job position is one for which adequate training can usually be obtained in vocational type schools, extension programs for out-of-school youths and adults on a full time basis; or by technical courses at the post-high school level for a period of about 2 years, such as a scientific and engineering technicians as trained by Southern Technical Institute.

(over)

d. What skill, knowledge, and abilities will be involved?

_____

_____

_____

e. What special materials, equipment, tools, and instruments will be used?

_____

_____

_____

f. Title you suggest for this new job:

_____

_____

_____

g. Number _____* (assigned by enumerator) Cols. 11-13

4. Training required for above type of new technician

CHECK IN THE LIST BELOW THE FIELDS OF STUDY REQUIRED FOR INITIAL EMPLOYMENT

a.	Mathematics through Geometry	_____	Col. 14
b.	Mathematics through Calculus	_____	Col. 15
c.	Statistics	_____	Col. 16
d.	Quality control (Statistical)	_____	Col. 17
e.	Theoretical Physics	_____	Col. 18
f.	Applied Physics	_____	Col. 19
g.	Nuclear Physics	_____	Col. 20
h.	Electricity	_____	Col. 21
i.	Basic Electronics	_____	Col. 22
j.	Advanced Electronics	_____	Col. 23
k.	Radio and Microwaves	_____	Col. 24
l.	Television	_____	Col. 25
m.	Communications Technology	_____	Col. 26
n.	Circuit Design	_____	Col. 27
o.	Engineering Drawing	_____	Col. 28
p.	Engineering Design	_____	Col. 29
q.	Basic Chemistry	_____	Col. 30
r.	Applied Chemistry	_____	Col. 31
s.	Plastics Theory	_____	Col. 32
t.	Metallurgy	_____	Col. 33
u.	Machine Shop	_____	Col. 34
v.	Welding Technology	_____	Col. 35
w.	Heat Treatment of Metals	_____	Col. 36
x.	Refrigeration	_____	Col. 37

(over)

y.	Air Conditioning	_____	Col. 38
z.	Mechanics	_____	Col. 39
aa.	Hydraulics	_____	Col. 40
bb.	Methods Engineering	_____	Col. 41
cc.	Time and Motion Study	_____	Col. 42
dd.	Plant Layout	_____	Col. 43
ee.	Instruments Technology	_____	Col. 44
ff.	Computer Technology	_____	Col. 45
gg.	Construction Methodology	_____	Col. 46
hh.	Surveying	_____	Col. 47
ii.	Photogrammetry	_____	Col. 48
jj.	Standards and Specifications	_____	Col. 49
kk.	Rocket Theory	_____	Col. 50
ll.	Propulsion Fuels	_____	Col. 51
mm.	Cybernetics	_____	Col. 52
nn.	Telemetry	_____	Col. 53
oo.	Radar Theory	_____	Col. 54
pp.	Technical reporting and writing	_____	Col. 55
qq.	Public Speaking	_____	Col. 56
rr.	Communication Skills[2]	_____	Col. 57
ss.	_____	_____	
tt.	_____	_____	
uu.	_____	_____	
vv.	_____	_____	
ww.	_____	_____	
xx.	_____	_____	
yy.	_____	_____	
zz.	_____	_____	

5. Summarize in your own words the sort of man you will need for the type of job you visualize for this work, touching in a general way on the technical training you would like for him to have.

_____

_____

_____

6. Estimate the number of new technicians[3] of the type of analyzed above which this company will probably need in the present plant by:

a. June 1965	_____	Cols. 66-68
b. July 1967	_____	Cols. 69-71

---

[2]Human relations, perception of social personal needs, developed ability to be articulate, ability to pursue own personal advance without offense, and proper timing and ability to be identified. The younger person knows how to work with older workers and industrialists.

[3]In preparing forecasts for 1965 and 1967, take into account growth prospects for your industry, and consider also that experts project a relatively greater use of technical type workers in future years. Some technical workers, however, will be absorbed by new types of technical workers; others may be replaced altogether.

(over)

7. State how many trainees which are currently in training[4] fill this position. (If none, enter a zero.)

8. Please estimate the total number of workers this firm will train for this position by: (If none, enter a zero.)

   a. June 1965 _____ Cols. 74-76
   b. June 1967 _____ Cols. 77-79

9. Enumerator _____

10. Editor's Initials _____ Date _____

---

[4]Formal type of training includes: on-the-job training, apprenticeship, formal-organized, unit classroom, or other type of in-plant training.

EXHIBIT 2

Check-off List of Technological Trends in the Textile Industry

School of Industrial Management
Engineering Experiment Station
Georgia Institute of Technology

Office of Manpower
Automation and Training
U.S. Department of Labor
Budget Bureau No. _____

I. TECHNOLOGICAL CHANGES IN THE TEXTILE INDUSTRY

A. Exploiting technological change in the textile industry will give your company the following advantages:

1. Cost savings from newer processes.
2. First entry into the market with improved products or new products.
3. Gain in market share from newer products.
4. High rate of profits from rising volume.
5. Competitors are kept off balance by faster adoptions of technological change.
6. Pride of organization from faster adoption of technology.

B. The following are the most important technological changes already listed by several companies in the textile industry. (CHECK THOSE WHICH AFFECT YOUR COMPANY SPECIFICALLY.)

( ) 1. Improved raw materials involving synthetics. Multiple fiber blends involving both synthetics and natural fibers will probably increase in importance. Methods of testing to determine qualities, quantities, and characteristics of fiber are growing in significance.

( ) 2. Since size of unit for manual handling has reached the limit, the trend is toward automatic handling with expensive equipment.

( ) 3. In recent years a complete breakthrough in textile machinery has occurred, leading toward automation of textile operations. There are larger, more expensive continuous flow machines; this requires synchronization of machines, development of automatic transfer machines. This results in increased speed of operations, larger packages. All of this means more sophisticated process controls, electronic and mechanical, to maintain flow and product uniformity, including production scheduling.

( ) 4. The trend toward expensive, complex machinery, involving electronic mechanisms and often also hydraulic or pneumatic, enlarge the problem of preventive maintenance.

( ) 5. The finishing of fabrics is changing and chemical technology, including coating for some types of products, is becoming more important and also more complex.

( ) 6. The textile mills serving the automobile industry are striving for a fabric that will equal the normal life of the automobile. Tire manufacturers are pursuing development of a tire without fabric materials.

( ) 7. The computer is of growing importance for data processing and management controls. In time computer use for production planning will grow.

( ) 8. Greater emphasis on quality control, systems analysis, and the other tools of scientific management.

( ) 9. Emphasis on design and packaging will remain high. The style factor is becoming more important in all phases of industry.

(over)

( )10. The independent mills are not able to move as rapidly toward automation and computers as the larger integrated concerns. They are, however, going to high speeds and higher drafts, to machinery with anti-friction bearings, electronically controlled, coupled with hydraulic or pneumatic systems.

( )11. Work is being done on elimination of some of the process--go from opening to cards, sliver to direct spinning, from coarse roving, and elimination of slashing.

( )12. The large integrated textile companies are moving toward diversified types of production, involving in time lines of products not closely related to present products.

C. Additional technological problems you have:

_____

_____

_____

_____

_____

_____

_____

D. Name of persons designated to work with us on technological change:

_____

_____

PLEASE RETURN A COPY OF THIS PAGE WITH THE QUESTIONNAIRE.

EXHIBIT 3

Analysis of Sample Size of Estimated Requirements
of New Technicians in 1 year

Poisson Approximation on Frequency Distribution of Number of New Technicians Required by the Georgia Textile Industry (One Year Period)

Job Code	Frequency of Demand			Number of Jobs	Mean
	0	1	2 or more		
0401	26 (26.2)	3 (2.7)	0	3	0.1034
0502	28 (26.2)	0 (2.7)	1	3	0.1034
0503	29	0	0	0	0
0509	28 (28.01)	1 (0.96)	0	1	0.0345
0510	29	0	0	0	0
1201	29	0	0	0	0
1202	28 (28.01)	1 (0.96)	0	1	0.0345
1419	29	0	0	0	0
1903	28	1	0	1	0.0345
2001	29	0	0	0	0
2702	27 (27.1)	2 (1.9)	0	2	0.0690
TOTAL	310 (307.8)	8 (10.9)	1 (0.2)	11	0.0345

The analysis above indicates that the number of establishments reporting a need for new technicians in one year is too few to apply statistical inference. Therefore, it is impossible to design sample size for the one year data.

EXHIBIT 4

Questionnaire Including Instructions

The questionnaire and instructions will be integrated into one complete form of 8 pages printed on both sides. Because of the printing problem, both parts of the questionnaire, however, are presented subsequently as single pages in the sequence in which they will occur in the printed form.

chool of Industrial Management
ngineering Experiment Station
eorgia Institute of Technology

Office of Manpower,
Automation and Training
U.S. Department of Labor
Budget Bureau No. _____
Approval Expires Dec. 31, 1964

REPLY FOR UNIT SHOWN AT LEFT

Although this survey is based on a sample of textile firms in Georgia, all multi-unit companies are included. Multi-unit companies will have delivered a form for each unit reporting under the Georgia Unemployment Insurance Regulations. We earnestly request that each be reported on separately in order to facilitate the computer analysis.

A SURVEY OF
NEW TECHNICIANS IN THE
TEXTILE INDUSTRY, 1964

Your reply will be held strictly confidential.

GENERAL INSTRUCTIONS

Please answer all of the questions for this establishment as completely as possible. If the company is about to go out of business, state this but return the questionnaire to: Dr. John L. Fulmer, School of Industrial Management, Georgia Tech, Atlanta, Georgia 30332. The EMPLOYER'S COPY is for your use.

Assumptions for Estimating Future Employment: (1) Current international tension will continue but there will be no World War involving the U.S. (2) Scientific advance and technological change will accelerate. (3) Supply of scientists, engineers, and technical and skilled workers will expand from better training facilities. (4) Georgia's economy will continue to grow and prosper.

EXPLANATIONS FOR ENTERING DATA

. Date of this questionnaire _____
Show date you complete the questionnaire to nearest 15th of month.

. What was employment in this establishment March 1962. _____
Report same number as on ESA-4 Forms to Georgia Department of Labor.

. Total current employment. _____
Average number employed during the month you fill out this questionnaire.

. Estimate total number of workers you expect will be working in this estabment:
a. One year from date of questionnaire _____
b. Three years from date of questionnaire _____

. Show below the type of company training regularly provided to train technicians. (CHECK ONE APPROPRIATE)

	( )		Number Completing Training Last 12 Months
a. On-the-job training	___	(1)	_____
b. Company classroom	___	(2)	_____
c. Night school of college	___	(3)	_____
d. Night school of vocational-technical school	___	(4)	_____
e. Industry training short courses	___	(5)	_____
f. Major suppliers (Dupont, etc.)	___	(6)	_____
g. Other	___	(7)	_____

Technician type workers perform specific tasks which are functional parts of scientific or engineering activities that require knowledge of basic mathematical, engineering, and scientific principles.

Formal training is defined here to include all planned types of training by the company management. Workers attend class or they are in a program of on-the-job training. The purpose is to impart skills or techniques to the workers, qualifying them for more responsible and important jobs.

INSTRUCTIONS FOR COMPLETING QUESTIONNAIRE ON NEW TECHNICIANS

FIRST, determine from the above outline of technological trends, attached to the FIRST letter addressed to your President, those technological trends affecting your company operations and markets.

SECOND, study these trends in relation to the new Plant Job Titles given later in the Questionnaire. Analyze these technological trends in relation to the detailed specifications given. Determine if one or more will help solve your technological problems. If so, fill out completely all 13 columns for any jobs that you need. If the answer to any column, or even to several columns is zero, please enter zero. CAUTION: Some of these jobs do not apply to your company at all. Yet, some others may be similar to a technician you need. In that case, if the job specification covers in a major sense the type of new technician you are just adding, or will need in the next three years, you should fill out the entire line as completely as possible in accord with instructions. NOTE: If your company is not using, or will not need any one of these jobs in 1 year or 3 years, enter zero in all the columns by all jobs.

THIRD, study the following Specific Instructions to fill out all 13 columns on page 3 of the questionnaire. See page 3 of instructions for illustration.

Column 1: Job Code. This code has been entered for identification purposes only to facilitate reference to definitions given in subsequent pages.

Column 2: Plant Job Title. This column includes the Plant Job Titles developed by some companies in your industry during the course of interviews during the Summer of 1962. The job specifications associated with the Plant Job Title are also given.

Column 3: Number Filling in Part This Job. Enter in this column for the job title listed the number or people who are partially filling the job type now. This worker should be considered in the sense of not being completely trained but who is receiving the training to fully qualify him in the future for the job in question.

Columns 4 and 5: Additional Number of Technicians Expected to be Employed in 1 Year and 3 Years. Enter here the number of people which you expect to add in this Plant Job Type in 1 year and 3 years.

Columns 6 and 7: Training and Upgrading of Skilled Workers or Technicians. Enter in these columns the number of skilled or technical workers which you expect to train and upgrade into this Plant Job Type in 1 year and 3 years. Include also the worker or workers shown in Column 3 if training will be completed in either 1 year or 3 years.

Columns 8 and 9: Hiring from Outside Sources. Enter in these columns the number of employees for the Plant Job Type which you expect to hire directly from outside, i.e., from Vocational-Technical Schools and from other training programs.

Columns 10 and 11: Number of Skilled Workers or Technicians to be Displaced by New Technicians in 1 Year and 3 Years. Enter here the number of skilled or technical workers expected to be displaced by the new Plant Job Type in 1 year and 3 years. Any worker who will be upgraded to fill jobs in Columns 3, 4, or 5 should not be reported. These Columns, 10 and 11, refer rather to those skilled or technical workers presently employed who may lose their jobs as a result of adding the new technician in question. If none, enter zero.

Columns 12 and 13: Number of Skilled Workers or Technicians to be Added to Support New Technicians. Enter here the number of workers which you expect to hire for the first time to support new types of technicians hired in 1 year or 3 years. Do not include workers transferred from other positions to support the new technician in question. Report only those workers who will be hired for the first time to support the new technician. If none, enter zero.

ILLUSTRATION OF HOW ONE COMPANY FILLED OUT THE QUESTIONNAIRE

Confidential Confidential

Job Code	Plant Job Titles[a]	Number Filling in Part This Job[b]	Additional[c] Number Technicians Expected to be Employed		Additional Needs[d] to be Met by: Training and Upgrading of Skilled Workers or Technicians		Hiring from Outside Training Sources		Number of Skilled Workers or Technicians to be: Displaced by New Technicians		Added to Support New Technicians	
			1 yr	3 yrs	1 yr	3 yrs	1 yr	3 yrs	1 yr	3 yrs	1 yr	3 yrs
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
0401	Air Conditioning and Ventilating Technician	0	0	1	0	0	0	1	0	0	0	1
0502	Chemical Process Control Technician	0	0	0	0	0	0	0	0	0	0	0
0503	Chemical Technician	0	0	0	0	0	0	0	0	0	0	0
0509	Textile Chemical Technician	0	0	1	0	0	0	1	0	0	0	0
0510	Textile Finishing Technician	0	0	0	0	0	0	0	0	0	0	0
1201	Electrical and Electronic Technician	0	0	1	0	0	0	1	0	0	0	0
1202	Electrical Technician	1	0	0	0	0	0	0	0	0	0	0
1419	Textile Equipment Technician	0	0	1	0	1	0	0	0	0	0	0
1903	Industrial Engineering Technician	1	0	0	0	0	0	0	0	0	0	0
2001	Water Filter and Sewerage Plant Technician	0	0	0	0	0	0	0	0	0	0	0
2702	Textile Quality Control Technician	2	0	0	0	0	0	0	0	0	0	0

[a] NOTE: Check complete statement of job specifications, attached, before beginning.
[b] This worker is in process of getting training to fill the job.
[c] Be sure the number shown is in addition to the number shown in Column 3.
[d] Balance Columns 6 - 9 against Columns 4 and 5.

SUMMARY OF NEW TECHNICIANS NEEDED IN THIS PLANT IN ACCORD WITH INSTRUCTIONS
EXCLUDING COLLEGE TRAINED PEOPLE

Confidential Confidential

Job Code	Plant Job Titles[a]	Number Filling in Part This Job[b]	Additional[c] Number Technicians Expected to be Employed		Additional Needs[d] to be Met by: Training and Upgrading of Skilled Workers or Technicians		Hiring From Outside Training Sources		Number of Skilled Workers or Technicians to be: Displaced by New Technicians		Added to Support New Technicians	
			1 yr	3 yrs	1 yr	3 yrs	1 yr	3 yrs	1 yr	3 yrs	1 yr	3 yrs
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
0401	Air Conditioning and Ventilating Technician											
0502	Chemical Process Control Technician											
0503	Chemical Technician											
0509	Textile Chemical Technician											
0510	Textile Finishing Technician											
1201	Electrical and Electronic Technician											
1202	Electrical Technician											
1419	Textile Equipment Technician											
1903	Industrial Engineering Technician											
2001	Water Filter and Sewerage Plant Technician											
2702	Textile Quality Control Technician											
e/												
e/												

[a]NOTE: Before beginning, check attached statement of job specifications. [b]Worker in process of training to fill job. [c]Be sure number shown is in addition to number in Column 3. [d]Balance Columns 6 - 9 against Columns 4 and 5. [e]On reverse side of this page, please provide information requested about types of new technicians not covered above.

ANALYSIS OF NEEDS FOR NEW TYPES OF TECHNICAL WORKERS NOT IN QUESTIONNAIRE

I. First worker in importance...
Qualification analysis for new type of technical worker.[1/]

1. What will worker do _____

2. What skill, knowledge, and abilities will be necessary to fill the job.

3. What special instruments and equipment, or tools, will be used.

4. Plant job title you expect to assign this worker.[2/]

II. Second worker in importance...
Qualification analysis for new type of technical worker.[1/]

1. What will worker do _____

2. What skill, knowledge, and abilities will be necessary to fill the job.

3. What special instruments and equipment, or tools, will be used.

4. Plant job title you expect to assign this worker.[2/]

III. If you have more than 2 new types of technical workers to report here, add additional pages of both sections of the questionnaire as required.

[1/] Before filling out this form, please read again the definition of Technician and New Technician workers given in the next page.

[2/] NOTE: Transfer title to the first section preceding of the questionnaire and complete all 13 columns.

I. SOLVING TECHNOLOGICAL PROBLEMS

The most important consideration is to employ or train technicians with the technical know-how to adapt the technological changes to the advantage of your company operations or company markets. It is most important that you get all your technical people thinking about the brainpower, the skillpower, which will be needed to solve technological problems. This group should probably include: the president, as chairman, director of engineering design and development (R & D in some companies), production processes, maintenance and services, systems and procedures, and personnel and training. This group should collectively study this problem and come up with the answers to your needs for new technicians.

Technician: The term is applied to one who performs specific tasks which are functional parts of scientific or engineering activities requiring knowledge of fundamental theory of the scientific and mathematical principles pertinent to the special field of work. Technicians are more intensively trained in basic theory than craftsmen. They occur between engineers and scientists, on the one hand, and craftsmen on the other. Their work is usually in a specialized field of research design, development and/or construction; in exploration, measurement and analysis; and/or application of basic scientific concepts; and in control of production facilities and manpower. Illustration of a well-recognized technician is YARN TESTER. An example of a skilled worker, which is not a technician, is LOOM FIXER.

YARN TESTER
Examine the yarn in various processes to determine its standard of quality, strength, weight, twist per inch, and other physical characteristics. Understands basic characteristics of fibers and yarns and is able to determine processing difficulties which cause defects.

LOOM FIXER (textile)
Inspects, maintains, and repairs looms: Puts in new harness straps and replaces worn out shuttles. Installs new warp beams and sets, harness, reed, and drop wires into position, and ties warp ends to cloth beam.

New Technicians: This term is involved when there is an opening for a technical worker as defined above. It may be partially filled by a worker (skilled or technical) who is incompletely qualified to solve technical problems caused by the industry's technological trends given above. This worker may be a skilled worker or technician with incomplete or partial qualifications who is in process of taking training, formally or informally, to get upgraded into the job. A list of these jobs already identified for the textile industry has been previously given in a questionnaire. All blanks in it should be filled out completely even if zeroes are necessary. You may find a need in your company for other technicians not shown in the questionnaire. If so, the page next to the questionnaire is for this purpose. Report completely what each worker will do and other job requirements.

PLEASE TURN TO THE NEXT PAGE FOR A COMPLETE DISCUSSION OF JOB SPECIFICATIONS FOR ELEVEN NEW PLANT JOB TITLES IN THE TEXTILE INDUSTRY.

II. JOB SPECIFICATIONS FOR PLANT JOB TITLE OF NEW TECHNICIANS

0401 Air Conditioning and Ventilating Technician
(5-83.941 Refrigeration Mechanic, and ind.; 5-83 Air Conditioning Mechanic, Commercial, any ind.)[1/]

Supervises, installs, tests, develops preventive maintenance plans for, and repairs air conditioning, ventilating, and refrigeration equipment. Must be able to read and understand blueprints and specifications and run and interpret tests. Works with air measuring devices such as pressure and velocity test equipment. Must also be able to work with conventional electrical testing equipment.

0502 Chemical Process Control Technician
(0-50.22 Laboratory Tester, prof. & kin.)

Operates between staff chemists and machine operators, testing or analyzing chemicals and materials entering and leaving process. Makes adjustments to bring processing operations into control to insure that product meets specifications. Uses colorimeters, makes density tests, and does quantitative analyses.

0503 Chemical Technician
(0-52.22 Laboratory Tester, prof. & kin.)

Operates a chemical testing laboratory investigating the use, cost, and improvement of all chemicals in production. Requires a basic knowledge of chemicals, the ability to study chemical properties and reactions, and some mechanical engineering knowledge.

0509 Textile Chemical Technician
(0-52.22 Laboratory Tester, prof. & kin.)

Uses various procedures specified by the American Association of Textile Coloring Chemists and tests specified by the American Society for Testing and Materials to check out dyes, e.g., comparisons of color strength, analyzes lubricants for fibers, etc. Serves to keep up with constant changes in materials and maintain constant control of the dyeing process. Will need a chemical and math background. Uses hot plates, ovens, color matching lights, sample dyeing equipment, weighing devices, fadeometers, and crock meters.

0510 Textile Finishing Technician
(0-52.22 Laboratory Tester, prof. & kin.)[1/]

Studies various chemicals available for finishing textile materials to determine and plan the chemical or combination of chemicals needed to meet specifications; maintains quality control after the goods are woven, and teaches others how to mix chemicals. Must know textile chemical tests, and be able to use mathematics to determine costs. Uses viscometers and calculating machines.

[1/] The Code Numbers and Job Titles given in parenthesis after most Job Titles for New Technicians designate either technicians or skilled workers included in the Dictionary of Occupational Titles, U.S. Department of Labor, Bureau of Employment Security, which have similar technical skills.

1201 Electrical and Electronic Technician
(0-67 Electronic Technician, prof. & kin.)[1/]

Does maintenance, adjusting, and trouble-shooting on electronic equipment. Must have a knowledge of electronics and electronic control instruments, e.g., temperature control equipment. Will use tube testers, ohmmeters, voltmeters, ammeters, and burner diagnostic machines. May be called upon to supervise others and to get along with operators.

1202 Electrical Technician
(0-67 Electrical Technician, prof. & kin.)

Installs, maintains, and repairs electrical equipment of a complicated circuit design including some sensitive electronic equipment. Must understand principles of electricity and basic electronics and be able to read circuits and wiring designs. Will use various electrical and some electronic test equipment.

1419 Textile Equipment Technician

Plans maintenance programs for mechanical, electrical, electronic, hydraulic, and pneumatic systems, diagnoses failures, determines corrective action and supervises repairs by skilled repairmen. Must have an intimate knowledge of equipment and skill in using testing equipment. Must be able to use electrical and electronic testing equipment, specialized hand tools designed for the equipment, velocity measuring devices, tachometers, flow gauges, and various types of vibration and balance equipment.

1903 Industrial Engineering Technician
(0-68.73 Industrial Engineering Technician, prof. & kin.)

Will be engaged in setting standards as jobs change through job analysis. (Does the elementary work of the industrial engineer at less cost.) May work from this position into the position of departmental foreman. Uses normal time study tools.

2001 Industrial Water Filter and Sewerage Plant Technician
(7-54.621 Water-Treatment Plant Operator (waterworks))

Operates water filter and sewerage treatment plant or has supervision over preparation of materials for disposal plant. Must have a knowledge of water pumps, pressure flow meters, and enough basic chemistry for the application and control of chemicals.

2702 Textile Quality Control Technician
(0-50.42 Cloth Tester, Quality-garment, textile; 0-50.41 Laboratory Tester (textiles) I; 0-50 Cloth Tester, garment; rubber goods)

Runs tests on count and weight of yarns and for fabrics, makes twist checks, yarn strength tests, moisture checks, and other physical tests to maintain a high level of quality control. Uses strength testers, twist counters, reels, balances, and moisture testers. Will work with all types of operative and management people.

[1/] Loc. cit.

EXHIBIT 5

Sample Letters to Multi-unit and Single Unit Companies

Letter to: President, Multi-unit Company, asking for appointment

Mr. William B. Adams
President

Dear Sir:

The Georgia Insitute of Technology, through sponsorship of the Office of Manpower, Automation and Training, U.S. Department of Labor, is in the process of developing methods and techniques to exploit to the maximum the findings from the very comprehensive study completed recently on Changing Technology in Georgia as they relate to new types of technical personnel needed in the State's economy. The main idea is that changing technology creates the need for new technical skills. It has been found that updated technical skills enable companies to move more promptly to gain from advances in science.

Your company is among the sample of companies in the Georgia Textile Industry which we are most anxious to include in this analysis. I should, therefore, like to request an appointment to discuss this plan and its practicality with those responsible for technological development and manpower in your firm. It would be most helpful if a joint meeting with any or all of the following could be arranged: Director of Research and Development, Chief Industrial Engineer, Engineer in Charge of Production or Manufacturing, Maintenance and Service, and your Director of Personnel and Training. Not over an hour or so would be required in this joint meeting, although it may be necessary to extend the time with individuals, depending upon the interest in each case.

I should like to have an appointment or , in order to meet a tight time schedule on these company interviews. If it is impossible for key personnel in your company to make this appointment, please specify another date and we shall try to make necessary arrangements.

Very truly yours,

First Phase Letter to: President, Single Unit Company

Mr. Elton A. Jones, President
X.Y.Z. Company
U.S.A.

Dear Sir:

The Georgia Institute of Technology is cooperating with the Office of Manpower, Automation and Training, U.S. Department of Labor, in a state-wide study of technological problems of the textile industry and their impact on emerging new technical skills. Mr. John Doe, Executive Vice President of the Textile Manufacturers Association, and Dean Allen Jones, School of Textiles, College are local sponsors of the study.

Intensive interviews with a small sample of firms in the Textile Industry of Georgia have already summarized numerous technological problems and trends in the textile industry. Those who have participated in the studies to date have expressed the opinion that this research will help move the textile industry forward more rapidly. We are enclosing a copy of this summary for your study and we solicit most earnestly your cooperation in this study.

Specifically, we request that you appoint the person in your company who is normally responsible for analyzing technological change and making recommendations relative to it to work with us on this study of technology. Include, also, any other persons on the committee, who are concerned with technology, such as: production processes, engineering and design, etc.

As a first step, the person designated to cooperate in this study, and any others, should check off the technological problems in the enclosed summary sheets which are of most concern to your company. Any additional technological problems should be listed on the second page. Prepare a duplicate copy of the form in order to retain one for further study of your committee. The other copy should be mailed to the undersigned.

Finally, enter in Section I - D the name of the person whom you have designated in order that we may, with your permission, contact him relative to further details on this problem. We should be most grateful for a reply by in order that we can meet a very close time schedule.

Thank you for your cooperation in this matter.

Very truly yours,

Second Phase Letter to: Person Designated by President, Single Unit Company

Mr. John Doe, Director
Research and Development

Dear Sir:

I am pleased that you have been designated by your company to work with Dr. Green and me on changing technology in the Georgia Textile Industry and its impact on the needs for new technical personnel.

Recently, your company filed with us a summary of technological trends which are affecting your operations. We should now like for you to reexamine these trends as they relate to the need for new types of technicians, i.e., personnel operating between scientists and engineers and highly skilled craftsmen. According to committees similar to yours in other companies in the textile industry, the technicians described in the enclosed questionnaire will provide, in most cases, the new technical competence required by your industry to meet current problems created by changing technology.

In order to build up adequate estimates of emerging new types of technicians in the textile industry, we request that you report in the enclosed questionnaire your needs, if any, for new technicians in your operations. You will find complete instructions for filling out each column on the back of the first page. If your company requires a new type of technician not listed in the questionnaire, you should complete the last page of the questionnaire to show what will be required of such workers. The EMPLOYER'S COPY of the questionnaire should be completed, also, and retained in your files.

We should be most grateful if you would return the completed questionnaire to the undersigned by , if possible. When the report is completed, you will receive a copy.

Thank you for your help on this project which should contribute to more rapid progress in the textile industry.

Very truly yours,